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Materials Science Resources on the Web

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Abstract
This guide includes reference tools and educational resources related to materials that are freely available on the Internet and do not require subscription or registration on the part of individual researchers to access them. Most of these resources were created by educational institutions, scientific organizations, or are personal projects of materials scientists. A few commercial sites were included if they contained educational resources; however, sites were excluded if they were too much of a sales pitch for company products or services. Previous guides to web resources have become outdated and are filled by links to companies, professional societies, and government research agencies. I have chosen not to include such links in this guide, though many of the websites also happen to include a section of links to companies or societies.

Disciplines
Library and Information Science

Comments
This article is from *Issues in Science and Technology Librarianship* 34 (2002).

URLs in this document have been updated. Links enclosed in **{curly brackets}** have been changed. If a replacement link was located, the new URL was added and the link is active; if a new site could not be identified, the broken link was removed.

Refereed article

Science and Technology Resources on the Internet

Materials Science Resources on the Web

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Introduction to Materials Science

"Materials are the stuff from which all things are made, be they mundane household utensils or sophisticated integrated circuits that drive all of our modern technological society" (TMS Career Resource Center, n.d.). "Materials Science encompasses the study

of the structure and properties of any material, as well as using this body of knowledge to create new types of materials, and to tailor the properties of a material for specific uses. The field encompasses the spectrum of materials: metals, ceramics, polymers (plastics), semiconductors, and combinations of materials called composites" (Iowa State University, Department of Materials Science and Engineering 2001).

A very comprehensive description of the field of materials science and engineering is contained in the report "Materials Science and Engineering for the 1990s" prepared by the National Research Council's Committee on Materials Science and Engineering and published by the National Academy Press. Many materials scientists consider this to be a landmark report that has fueled considerable activity in research and development.

In 1999, the National Research Council Committee on Science & Engineering published another report "Materials Science and Engineering: Forging Stronger Links to Users." "Materials are the foundation and fabric of manufactured products. In fact, many leading commercial products and military systems could not exist without advanced materials and many of the new products critical to the nation's continued prosperity will come only through the development and commercialization of new materials. Thus, the field of materials science and engineering (MS&E) affects quality of life, industrial competitiveness, and the global environment."

Materials science heavily relies on physics, chemistry, other engineering fields such as mechanical and electrical engineering. Physical properties of materials are usually the deciding factor in choosing which materials should be used for a particular application. This involves looking at many factors such as: material composition and structure (chemistry), fracture and stress analysis (mechanical engineering), conductivity (electrical engineering), and optical and thermal properties (physics) to name a few. It also involves processing and production methods. Research in this area involves many peripheral areas including: crystallography, microscopy, mineralogy, photonics, and powder diffraction.

Scope of this guide

Due to the diversity of subject areas covered by materials science, this guide is intended to provide a core list (not a comprehensive one). Electronic materials, nanotechnology and micromaterials are currently very hot areas of interest to materials scientists so they have been included in the guide along with the core resources. This guide does not include many other materials science resources that are available in libraries, both in paper copy and via subscriptions to electronic databases, since the access points and call numbers will vary for each library.

This guide includes reference tools and educational resources related to materials that are freely available on the Internet and do not require subscription or registration on the part of individual researchers to access them. Most of these resources were created by educational institutions, scientific organizations, or are personal projects of materials scientists. A few commercial sites were included if they contained educational resources; however, sites were excluded if they were too much of a sales pitch for company

products or services. Previous guides to web resources have become outdated and are filled by links to companies, professional societies, and government research agencies. I have chosen not to include such links in this guide, though many of the websites also happen to include a section of links to companies or societies. Please consult one of the following if you are interested in this type of resource:

Company info - The Minerals, Metals & Materials Society (TMS) Career Resource Center maintains an excellent page, arranged alphabetically by company, with hot links to individual materials companies and includes information on "type of material" for each company.
http://www.crc4mse.org/resources/industry.html

The Materials Research Society maintains three very extensive directories -- professional societies, academic departments, and government organizations (including national laboratories):
{http://www.mrs.org/gateway/}

Methods

The sites contained in this guide are a compilation of several years of web surfing while looking for useful sites to assist in answering reference questions related to materials science. I visited the web sites of several university libraries that support well-known programs in materials science, made notes of individual worthwhile sites, and added to the listing by consulting the following resources:

EDinformatics Directory - Click on Science, then Technology, then Materials
http://www.edinformatics.com/

Internet for Materials Engineering - from EEVL's RDN Virtual Training Suite
{http://www.vts.intute.ac.uk/tutorial/materials/index.htm}

MaterSci -- A searchable database of resources related to Materials Science and Metallurgy.
{http://www.matersci.net/}

MatPro: Materials and Processes Database -- advanced materials database.
{http://amptiac.iitri.org/MATPRO/}

SciTechResources.gov - Sponsored by NTIS, it contains links to government resources related to science and technology.
{http://www.scitechresources.gov/}

Scout Report.
{http://scout.wisc.edu/Reports/ScoutReport/Current/}

General Sources

A+ Materials Science and Engineering: Glossary of Terms - This is a very extensive glossary put together by Justin McCarthy, a materials engineer with Lockheed Martin Naval Electronics and Surveillance Systems. This project started when Justin was a student needing definitions to assist in his coursework. Some he has created based on other inadequate definitions and others were culled from various sources. {http://www13.brinkster.com/justinmc/glossary/index.html}

Career Resource Center: MSE, Materials Science & Engineering - This is a very entertaining series of pages aimed at the general public. A brief introduction and history of MSE are provided as well as a variety of pages full of career information. This site is provided as a service of The Minerals, Metals & Materials Society (TMS). http://www.crc4mse.org/

Materials Algorithms Project (MAP) - MAP provides algorithms for use in the modelling of materials. It features general information about MAP, a library of downloadable programs, subroutines, and functions for the modelling of materials. MAP owes its origins to the National Physical Laboratory and the Phase Transformations Group of the University of Cambridge. It is a non-profit venture, sponsored originally by the Engineering and Physical Sciences Research Council (EPSRC) of the United Kingdom.
http://www.msm.cam.ac.uk/map/mapmain.html

Ceramics

About Ceramics: Introduction to Ceramics - An excellent introductory guide put together by the American Ceramic Society. It contains a definition and history of ceramics, manufacturing processes, and their impact on society. {http://ceramics.org/knowledge-center/ceramic-resource-center/}

Ceramic Fact Sheets - Also put out by the American Ceramic Society, each brief fact sheet describes uses and applications of ceramics in a particular industry. Topics included are: aerospace, automobiles, consumer products, electronics, environment, fiber optics, medicine, and military applications. Provides introductory information intended to spark interest in ceramics and show how important ceramics are in various industries. {http://www.ceramics.org/acers5/news/factsheets.asp}

Ceramics WebBook: a Resource for Information about Ceramics - This site provides links to three NIST ceramics databases (High-Temperature Superconducting Materials Database, Structural Ceramics Database, and Property Data Summaries) topical datasets, and links to other ceramics resources. The databases are searchable by: author, chemical family, structure type, properties, and publication information. Search results include bibliographic citation(s) and specific property data mentioned in the original publication(s). The data is evaluated and maintained by the Ceramics Division of the Materials Science and Engineering Laboratory at NIST (National Institute of Standards and Technology).
http://www.ceramics.nist.gov/webbook/webbook.htm

ClayLab.Net - Resource pages for clays and clay minerals supported by the University of Heidelberg, Germany. Of particular interest are the links to online lecture notes and research information, standards and software.
{http://www.claylab.net/}

Composites

Composites Corner - This is a guide to corporate activities in the area of advanced composites. The Turner Moss Company blatantly sponsors this site with the aim of selling more publications; however, it has a very useful feature in the extensive listing of company profiles. This page also provides links to web sites pertaining to advanced composite materials industry and research.
{http://www.advmat.com/links.html}

Worldwide Composites Search Engine - This is primarily a search engine of composite companies. It also has a couple of unique, and useful, features in the "surplus materials database" for purchasing composites from places that have extra supplies on hand and "key personnel database" for locating particular researchers.
http://www.wwcomposites.com/

Educational Demonstrations & Exhibits

Challenge of Materials - This is an online exhibit from the Science Museum based in the UK (formerly the National Museum of Science & Industry). It provides excellent introductory information aimed at the general public. This is one of several digital exhibits on the exhibits page - the pages have recently been reorganized so it is no longer possible to provide a direct link to specific exhibits.
{ http://www.sciencemuseum.org.uk/visitmuseum/galleries/challenge_of_materials.aspx}

K-12 demos - Drexel University Department of Materials Engineering maintains a wonderful page of fun (and yet educational) links. They contain flashy graphics, movies, animations, and other types of media.
{http://www.materials.drexel.edu/mischot.html#k12}

Materials Interactive - This site uses advanced simulation techniques, using JAVA and VRML, to model the behavior of materials. It is put together by the National Physical Laboratory in the United Kingdom. Subjects include surfaces, laminate damage, electron backscatter patterns, educational, and experimental.
http://materials.npl.co.uk/

ViMS - Visualizations in Materials Science - by John C. Russ, Materials Science & Engineering Dept., North Carolina State University. The "home" site linked on many web pages is: {http://vims.ncsu.edu/cgi/index.acgi} but many of these links do not work properly since they do not provide proper directions for accessing it. ViMS is not directly accessible via the web - it requires downloading and unzipping of large files. This site has

an extensive table of contents with full text information about different areas of materials research. Chapters include: Atomic bonding; Crystal structures; Diffusion; Mechanical properties; Cold work and annealing; Nucleation and growth; Phase diagrams; Building materials; and many more. The best directions for access can be found at: {http://www.succeed.vt.edu/cdrom/Russ_VIMS/}

Metals

The Copper Page - This resource provides information on the uses, business, and trade of copper, advocating the copper industry. It also contains links to information on copper data, environmental and health effects of copper, history, prices, production, standards and properties, suppliers, and innovations. The Copper Data Center is a free, searchable database from Cambridge Scientific Abstracts that provides citations to relevant journal articles from 1965 to the present. The general information page contains many fun and interesting sites about copper - including the restoration of the Statue of Liberty. A search feature makes it easy to locate things without needing to know which link contains the relevant information.
{http://www.copper.org/}

Magnesium Home Page - This page was created by scientists at CSIRO in Australia. They modestly claim to be the "unofficial" site since "official" sites have recently been created; however, I find this site to be much better than any of the other magnesium sites. It is much easier to navigate and quickly find information on properties, uses, refining and production, and alloys. References are provided for the data and there is also a section for "further reading." It provides links to magnesium company profiles, a discussion group, conference calendar, and research organizations working with magnesium without all the commercial advertising found on other sites. It is designed for those interested in magnesium metal production & the production of magnesium metal components.
http://www.members.tripod.com/Mg/

Metals Profiles - Excellent information! This page is arranged alphabetically by metal. The profiles originally appeared in the 1999 edition of Metal Statistics, The Statistical Guide to North American Metals, published annually by AMM. Individual profiles include information such as: industry statistics, supply, demand, pricing, consumption, and mine output.
{http://www.amm.com/index2.htm?/ref/proflist.HTM}

The Nickel Page - This page is sponsored by the Nickel Producers Environmental Research Association (NiPERA) so it places a heavy emphasis on the environmental hazards of nickel. It provides information on the uses and properties of nickel and the safe use of nickel in the workplace.
http://www.nipera.org/

Photomicrograph Gallery - This site contains gorgeous, full color illustrated pages of metallographically prepared cross sections of nonferrous metals, predominantly precious metals. The home page is shows only black and white images, but if you click on a

particular image it is enlarged and shown in color. It also contains links to Microstructures of Copper and Copper Alloys and Other Imaging Sites.
{http://metallography.aasp.net/pictures.htm}

A Short History of Metals - by Alan W. Cramb, Department of Material Science and Engineering, Carnegie Mellon University. A very easy-to-read and entertaining history of the "earliest" metals to be discovered. It covers the history and use of gold, copper, silver, lead, tin, smelted iron, and mercury. There are 2 dead links to additional resources, which tells me it is probably not being maintained, but the page is still very worthwhile.
http://neon.mems.cmu.edu/cramb/Processing/history.html

Steel Works - Sponsored by the American Iron and Steel Institute, this page provides news, industry information, consumer guides, public policy issue papers, information about steel applications, facts & figures, and related links.
http://www.steel.org/

Microsystems & Semiconductors

Implications of Nanotechology - This is a very interesting page of annotated links to reports and web sites discussing the societal implications of nanoscience and nanotechnology. It contains both the pros and the cons of these issues, from scientists as well as "neo-Luddites."
{http://logistics.about.com/cs/implications/index.htm}

MEMS Clearinghouse - This is a repository of information on Micro-Electro-Mechanical Systems (MEMS). This site provides introductory information about MEMS (including a beginner's guide to MEMS processing), a materials database, and industry news. Some knowledge/background is assumed, since it is not aimed at the general public, but it is still a very good beginning level resource.
http://www.memsnet.org/

Nanotechnology database - Sponsored by the National Science Foundation and hosted by Loyola University, this is a portal to nanotechnology resources on the Internet. There is no search engine - sites are grouped by academic, industry, government laboratories, government agencies, professional societies, non-profit organizations, publications, and conferences. The listings are fairly extensive even though the site is still in its infancy.
{http://itri.loyola.edu/nanobase/}

Semiconductor Subway - A very interesting visual analogy to a subway. From the main page you can navigate using either a clickable subway map showing the various stations or a textual table of contents. It provides links to all manner of semiconductor and microsystems related information, including fabrication, TCAD, VLSI circuits, microelectromechanical systems, and computer integrated manufacturing. Maintained by MIT Microsystems Technology Laboratories.
http://www-mtl.mit.edu/semisubway/

Polymers

The Macrogalleria - This is an extremely comprehensive tutorial of polymer chemistry and the uses of polymers, geared to the nonspecialist. It is organized on the metaphor of a shopping mall to facilitate browsing of topics.
{http://www.pslc.ws/macrog.htm}

Plastics.com - Polymers DotCom users are redirected to this site. It provides a number of search engines for locating people, companies, products, news, and events for plastics professionals. Also provides definitions, acronyms, and the plastics hall of fame. The sections for an encyclopedia and trademarks are still in development. Plastics.com, inc. is privately held and was incorporated in June of 2000 in the states of Massachusetts and Delaware, USA.
http://www.plastics.com/

Plastics Resource: Information on Plastics and the Environment - Sponsored by the American Plastics Council, this site provides industry news, product facts, packaging information, and recycling of plastics. It has sections devoted to green living, resource conservation, recycling (for both professionals and communities), and information on proper and improper disposal.
{http://www.plasticsresource.com}

Polymer Chemistry Hypertext - This is a reference guide to concepts and equations in polymer chemistry, compiled by undergraduate students at the University of Missouri-Rolla. It also includes a gateway to relevant websites and an index to polymer movies on the web.
{http://www.polymerchemistryhypertext.com/}

Polymer Search on the Internet - A free Internet search engine dedicated to sites related to rubber, plastics and adhesives. This site has great potential, but is currently lacking in content since it requires sites to register if they want to be included.
http://www.polymer-search.com/

PPP Handbook: An Electronic Handbook for Polymer Properties - This is an electronic handbook for properties of polymers. It contains values of over 60 properties for 600+ polymers. The unique feature of the handbook is that it has estimated values as well as experimental values for many properties.
http://www.dtwassociates.com/ppphb_1.htm

Properties Data

Research is continually yielding new data concerning properties of various materials and this data can often be very difficult to locate. Some properties were discovered and published in standard handbooks long before electronic databases became available. Some properties are listed in company catalogs or on company web pages. Other

materials are still being researched and do not have property data available. To ensure a comprehensive search, researchers may need to consult a variety of resources. The ones listed below are mostly indexes or sites that have compiled the data in one handy place. If data is not available in one of the below sources, you may wish to try a search engine such as Google or an index or subscription database available in your nearest research library (e.g., Chemical Abstracts, EngNetBase, Engineered Materials Abstracts, or SciFinder).

Data and Properties Calculation Sites on the Web: Classical, Quantum & Statistical Thermodynamics & Mechanics - This is an extensive listing of links to thermodynamics-related resources, databanks, and software available on the Web. It was created by the Thermodynamics Research Lab at the University of Illinois - Chicago.
http://tigger.uic.edu/~mansoori/Thermodynamic.Data.and.Property_html

MatML - This is a unique site in that it provides information on efforts to develop an extensible markup language (XML) for materials property data. "Materials property data distributed on the World Wide Web in documents using hypertext markup language (HTML) present two problems for computer applications intending to use the data: interpretation and interoperability." The MatML effort is addressing these problems by developing an XML that will "permit the storage, transmission, and processing of materials property data distributed via the World Wide Web." It is sponsored by NIST.
{http://www.matml.org/}

MatWeb - This is a searchable database of property data on over 24,704 materials including metals, plastics, ceramics, and composites. Various companies who have these materials available for purchase submit the entries and there is a hotlink to suppliers on the properties page. Typical entries contain composition and recommended uses as well as chemical, mechanical, thermal, and electrical properties. This site allows someone to search for a particular material and see all the properties at a glance and then it provides links to the companies that can supply the material. The one drawback to this page is that the companies may require registration to access their site or have built in pop-up boxes with advertising.
http://www.matweb.com/

Phase Diagram Web - This site provides an extensive list of phase diagrams and links to software for calculating other diagrams. It mainly contains binary phase diagrams but a few ternary diagrams are found near the bottom of the page. Students worked out many of these diagrams. A disclaimer at the top of the page refers users to volume 3 of the ASM Handbook for the most accurate data.
{http://cyberbuzz.gatech.edu/asm_tms/phase_diagrams/}

Thermodex: an Index of Selected Thermodynamic Data Handbooks - This is a handy, searchable index of printed and web-based compilations of thermochemical and thermophysical data for chemical compounds and other substances. The search results consist of a list of handbooks that might contain this data. The database was created by staff of the Mallet Chemistry Library at the University of Texas - Austin, so results also contain call numbers for locating these handbooks in their library. Users will need to check

their local library catalogs to see if these resources are available in their library.
http://thermodex.lib.utexas.edu/

TPSX : Thermal Protection Systems Expert and Material Properties Database - TPSX is a personal computer-based program which serves as a database for advanced thermal protection material properties. Produced and maintained by engineers and scientists from the NASA Ames Research Center. The database is free, but users are required to register for access.
http://tpsx.arc.nasa.gov/

Where to Find Materials Safety Data Sheets on the Internet - There are many MSDS sites on the Internet - but each contains a very limited number of data sheets. Currently no one site provides all the available data sheets, but this compilation is a start in the right direction. This site is provided by Interactive Learning Paradigms, Incorporated. It gives background information on MSDS, including a definition and examples. It also supplies links to approximately 100 MSDS sites on the Internet and ways to locate MSDS using non-Internet sources.
http://www.ilpi.com/msds/

Strength of materials

What is NDT/NDE? This page, from the Center for Nondestructive Evaluation at Iowa State University, provides excellent definitions & introductory information on nondestructive testing and evaluation.
{http://www.cnde.iastate.edu/ncce/whatis.html}

Nondestructive Testing Online Community - This site is aimed at professionals in the Inspection and Nondestructive Testing community. It contains discussion boards, mailing lists, a classified ad section with job openings, newsletters and marketplace information.
http://www.ndt.org/

Strength of Materials - Put together by Engineers Edge, this site contains basic definitions and equations used to calculate the strength of materials. It also has an extensive list of links to other relevant sites.
http://www.engineersedge.com/strength_of_materials.htm

Strength of Materials - This University of Wisconsin - Stout, Department of Physics website provides an excellent online textbook. It also has links to a structural behavior glossary and engineering data reference tables.
{http://physics.uwstout.edu/StatStr/index.htm}

Surfaces & Corrosion

Corrosion Source - This is a portal to corrosion resources for materials industry and researchers. Hidden within a very busy page of commercial links there is a treasure trove

of useful links including: a very impressive library of technical literature, a section of handbooks, hot topics, and a learning center of information for amateurs and professionals.
http://www.corrosionsource.com/

Finishing Dot Com: the Address That Finishers Know by Instinct - This page was created by the American Electroplaters and Surface Finishers Society. Slightly hidden near the bottom of the main page, there is a link to an online technical library full of excellent reference information. In addition, the FAQ section of this site contains demos for science classes and a great page on "how to plate non-metallic things."
http://www.finishing.com/

Methods - This site provides detailed descriptions of various surface processing methods (including composites, coatings, powder metallurgy, thermodynamics and tribology) and links for further information. Put together by The Surface Processing & Mechanics Group at the Oak Ridge National Laboratory.
{http://www.ornl.gov/spm/methods/methods.htm}

National Paint and Coatings Association - This site provides a good history of the industry, glossary of terms, industry facts and a buyer's guide. It has sections for both consumer and industry information.
http://www.paint.org/

References

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